


Comisión Interamericana del Atún Tropical
Inter-American Tropical Tuna Commission

CIAT
IATTC

Yellowfin: Growth models currently utilized in IATTC stock assessment and future considerations

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Workshop on age and growth of bigeye and yellowfin tunas in the Pacific Ocean, La Jolla, CA, Jan 23-25, 2019

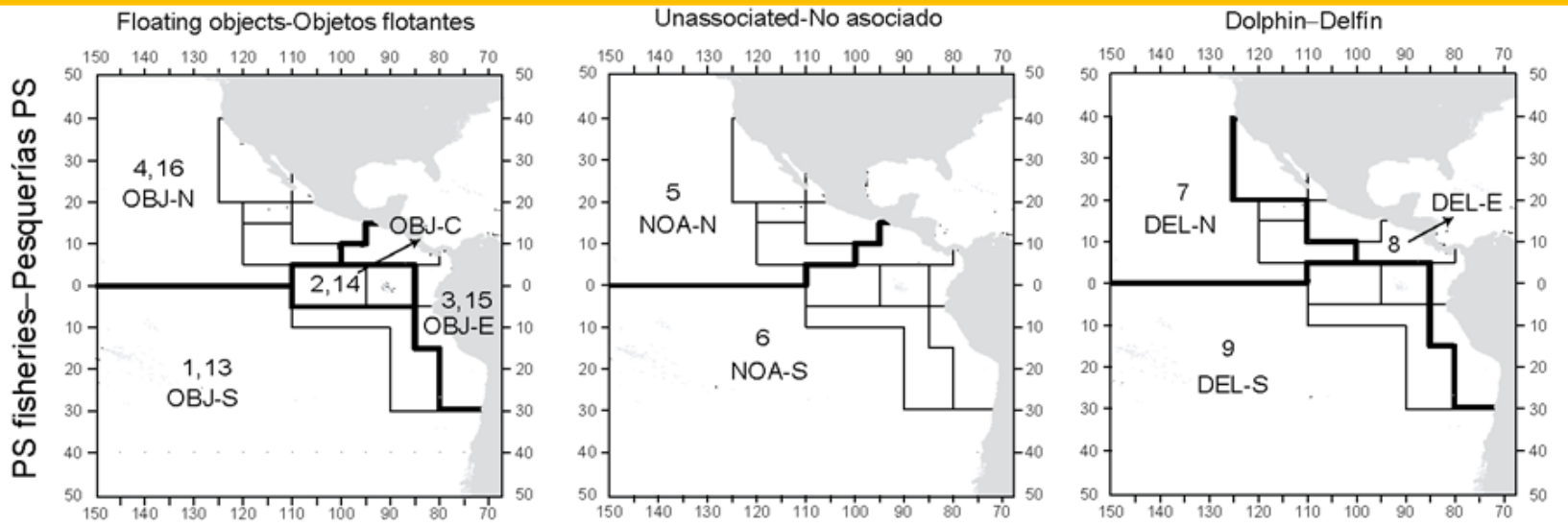
Outline

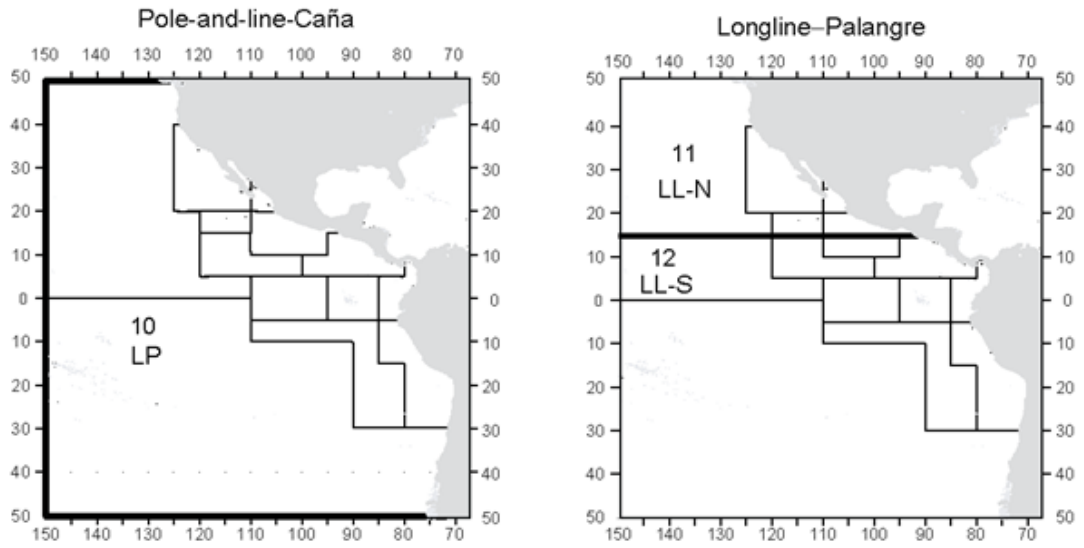
- Introduction to current IATTC yellowfin stock assessment
  - Length composition data in the IATTC EPO yellowfin stock assessment
- Specification of growth in the current stock assessment
- Estimation of growth within the stock assessment model
- The sensitivity of assessment results to the L2 growth parameter

IATTC yellowfin tuna stock assessment (base case)

- Integrated stock assessment model: Stock Synthesis v3.23
- Quarter-as-year: 1975-2017 with a model time step of one quarter (172 model years)
- One stock is assumed for the whole EPO: 16 fisheries + 2 surveys
- Sex-specific natural mortality
- Fit to 5 CPUE time series and size composition data
- Two fisheries with asymptotic selectivities
- Data-weighting: LL-S is the main index of abundance (CV=0.2), extra variability estimated for the other 4 indices, length-composition data with $\lambda=1$

YFT stock assessment fisheries definitions



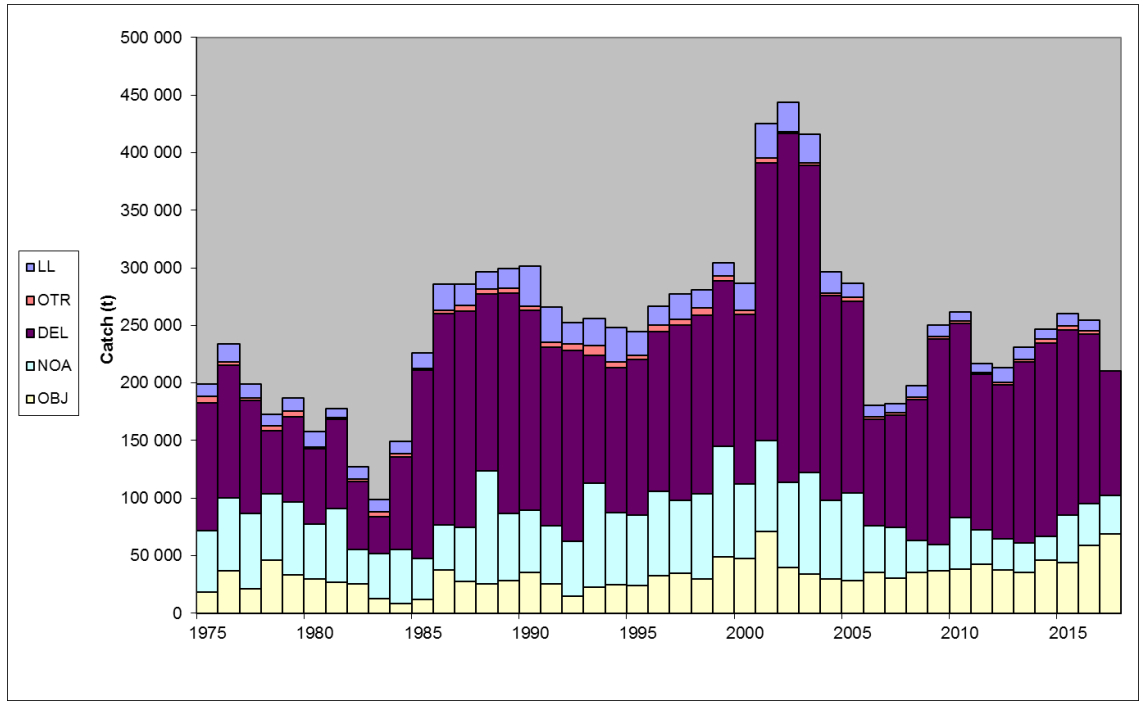


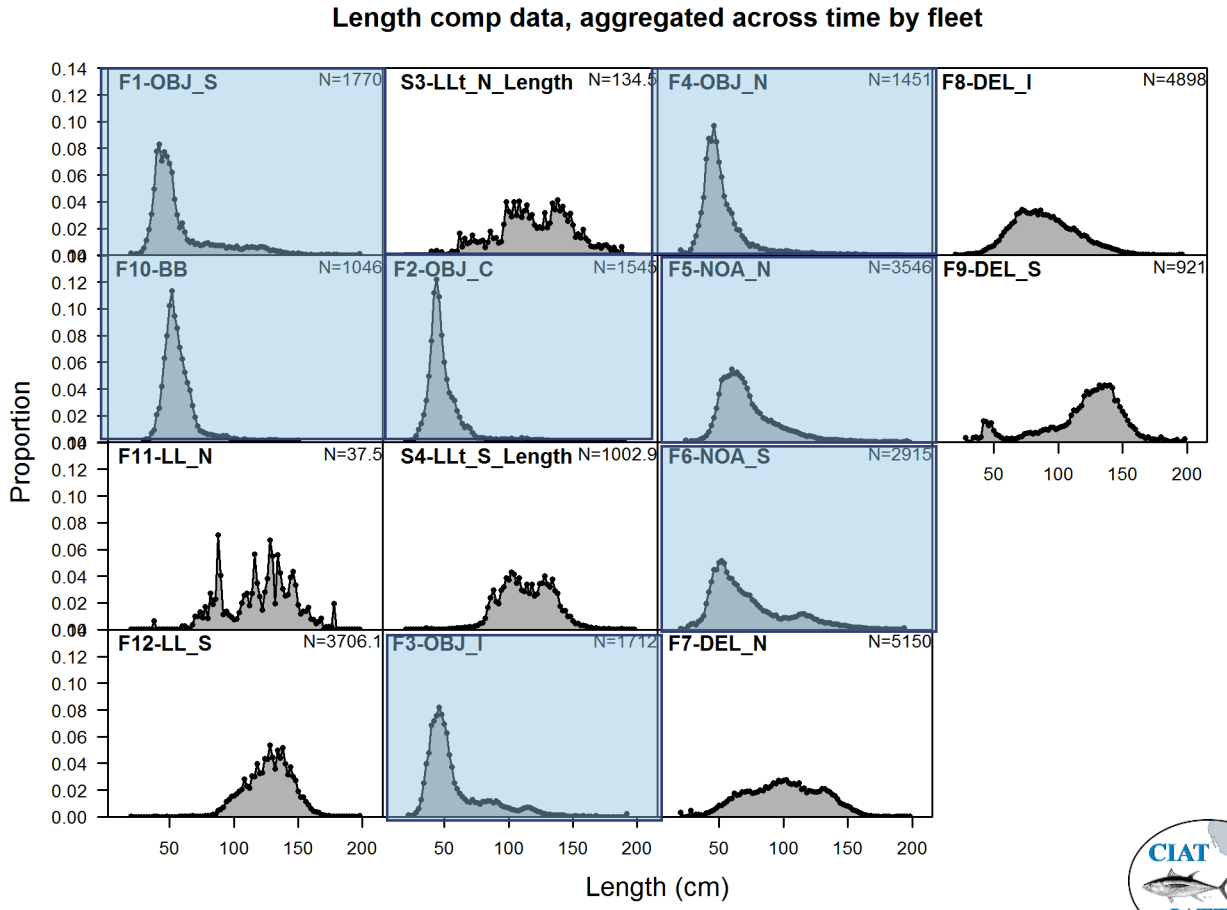
___ IATTC length-frequency sampling areas

___ fishery definition areas

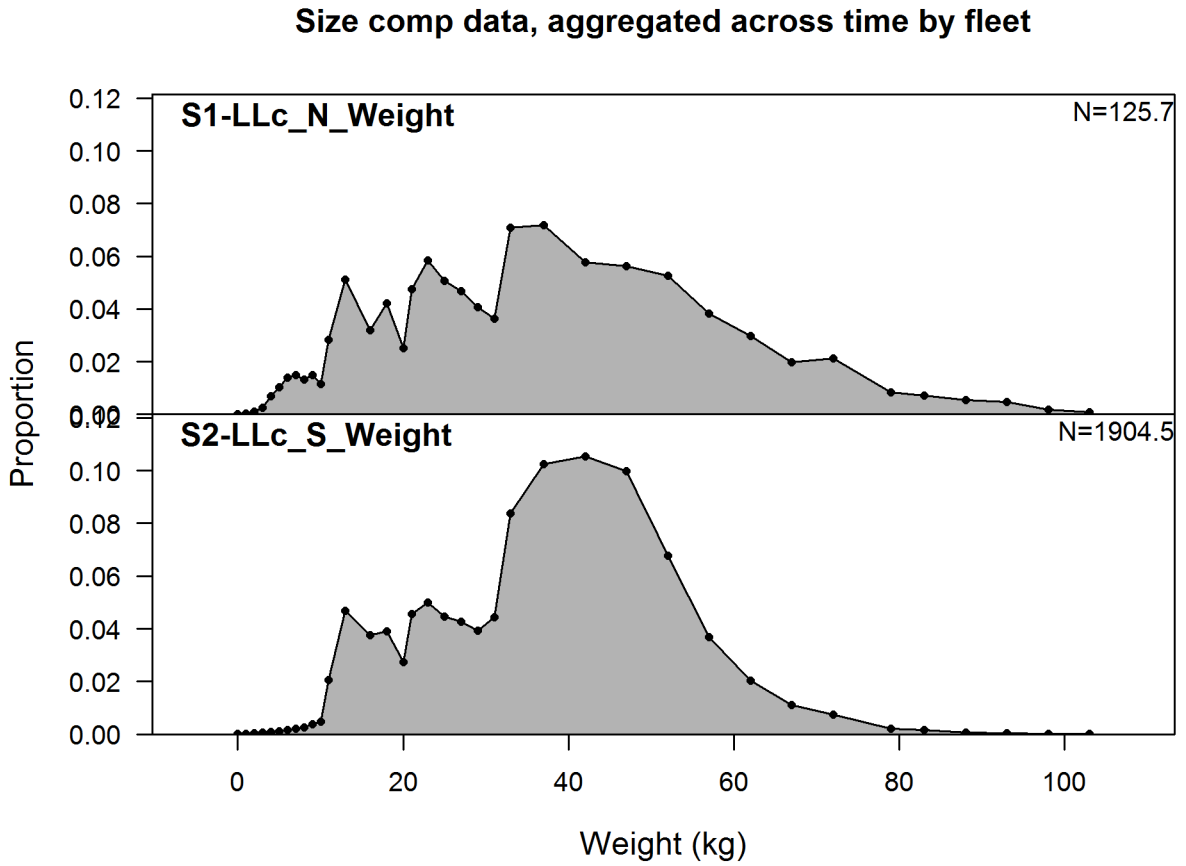
Size composition data in the IATTC EPO bigeye stock assessment

- purse-seine (PS) fishery (~ 98% of the catch in weight) and longline (LL) fishery

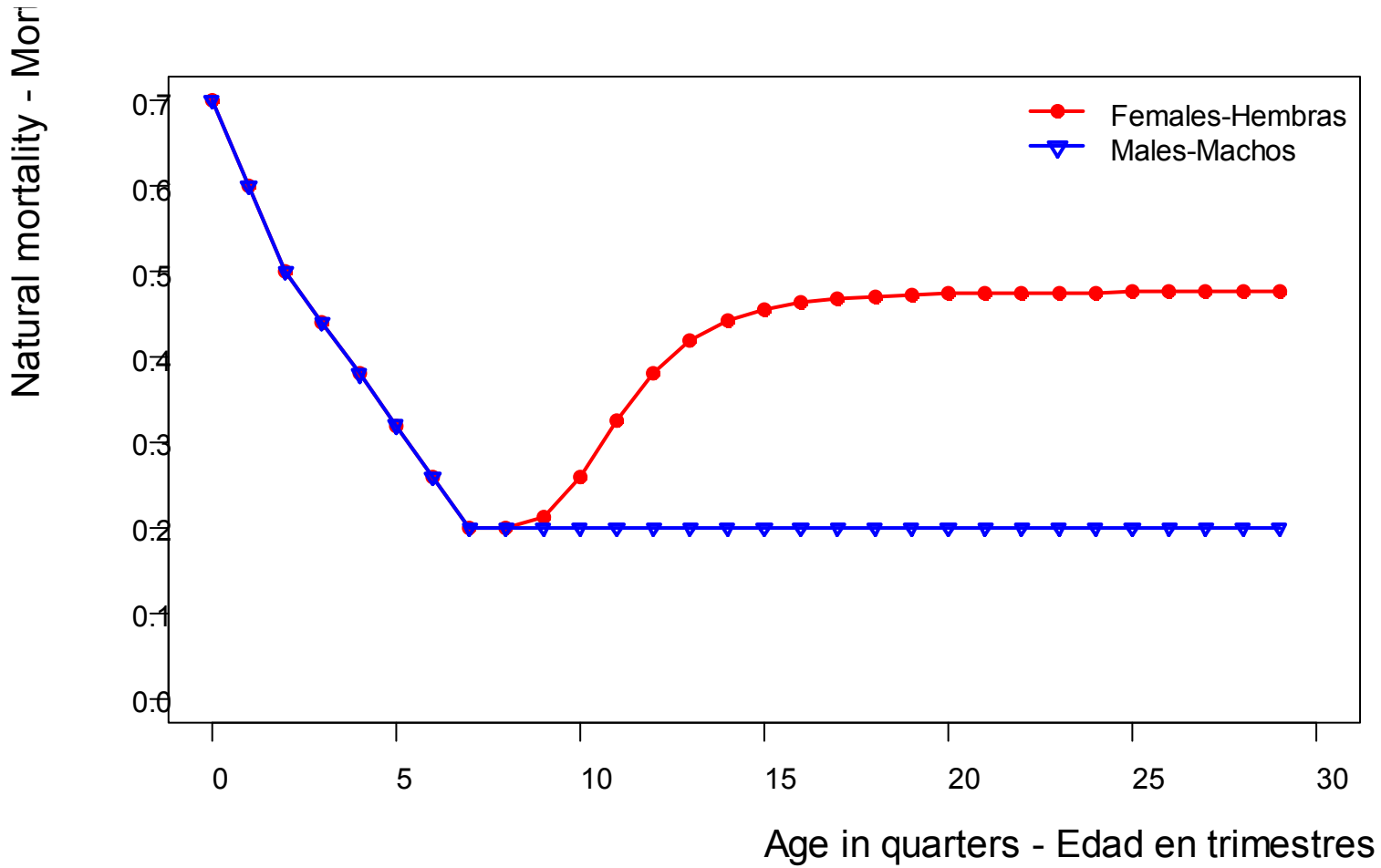




Weight composition data in the IATTC EPO yellowfin stock assessment



Mortality at age



Size composition data in the IATTC EPO yellowfin tuna stock assessment

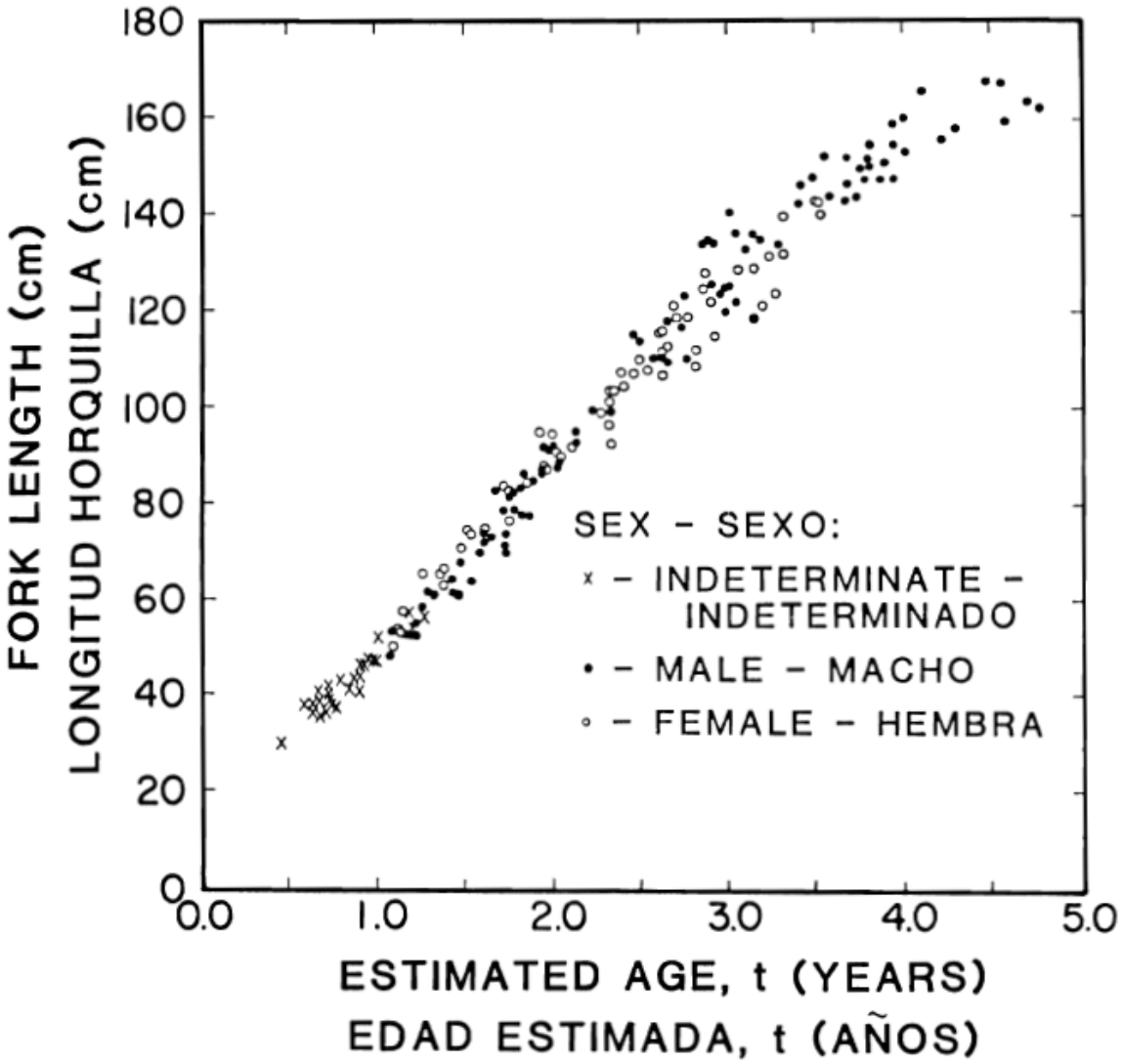
- Length composition from purse-seine and longline fisheries (commercial and training vessels)
- Spatial resolution of length-comp data: 5° by 10° for LL and 5° by 5° for PS (since 2000)
- Input sample size of PS length-comp = number of wells sampled
- Input sample size of LL length-comp = number of fish sampled * scaler (rescaled to have the same mean (~34) as PS length comp)
- 90 length bins with a bin size of 2cm (20, 22, …, 198 cm)

Specification of growth in current stock assessment

- The Richards growth curve is used (more flexible than the von Bertalanffy curve)

$$L_a = L_\infty \left(1 + \frac{1}{p} e^{-K(a-t_0)}\right)^{-p}$$

Growth curve (Wild, 1986)



Equation	Parameters				Standar	
	FL_∞	K	t_o	m	FL_∞	K
a) Ecuación	Parámetros				Errores	
	FL_∞	K	t_o	m	FL_∞	K
(2)	172.7	0.857	1.308		3.36	.0536
(1)	148.0(f)	1.720	2.000	2.903	–	.2117
(1)	149.0(f)	1.888	2.294	4.111	–	.1875
(2)	176.9	0.733	1.590		5.48	.0706
(1)	188.2	0.724	1.825	1.434	8.34	.1019

FIGURE 4. Sexually dimorphic growth in fork length for combined sampling years

Specification of growth in the stock assessment

Hoyle and Maunder (2006)

A - SCALA

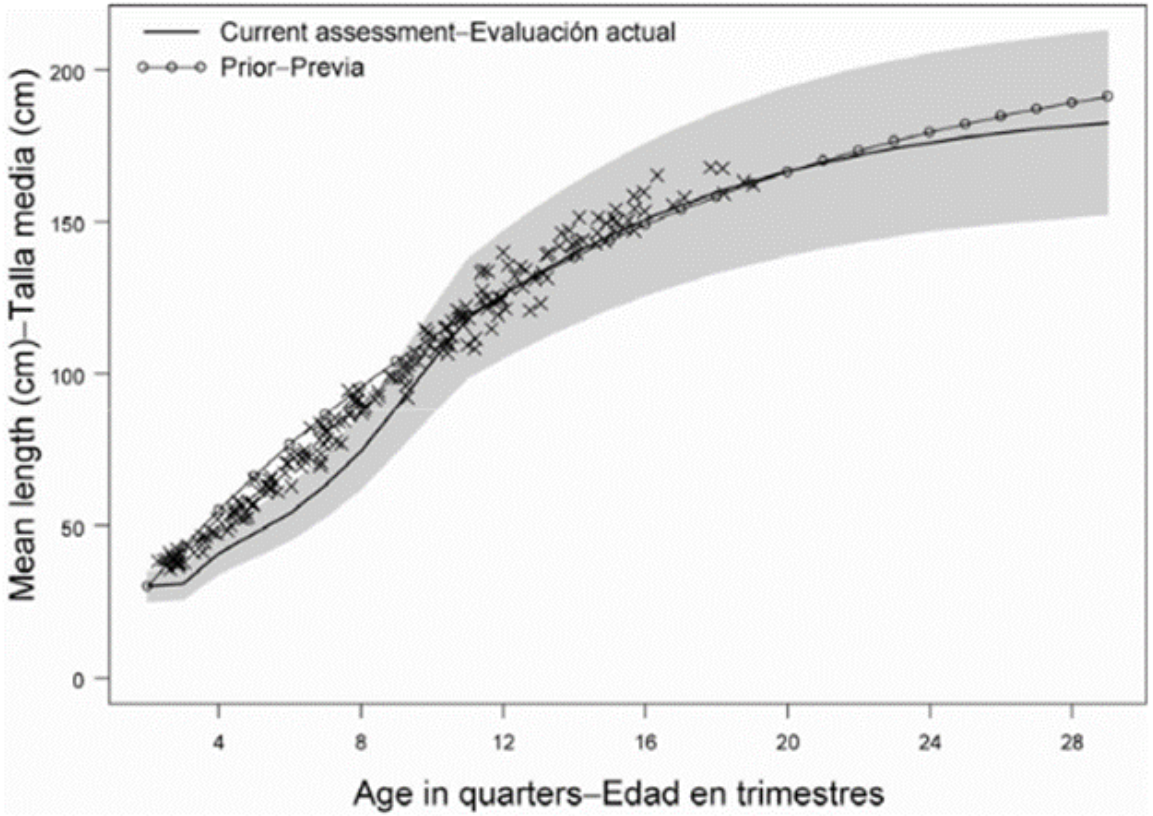


FIGURE 3.1. Growth curve estimated for the assessment of yellowfin tuna in the EPO (solid line). The connected points represent the mean length-at-age prior used in the assessment. The crosses represent length-at-age data from otoliths (Wild 1986). The shaded region represents the variation in length at age (± 2 standard deviations).

Specification of growth in the **current** stock assessment

Maunder and Aires-da-Silva (2009)

The current base case model assumes that the average L2 for males and females is 182.8 cm with a CV of about 10%, i.e. 95% of the fish 29 quarters old should have 147.1 to 218.5.

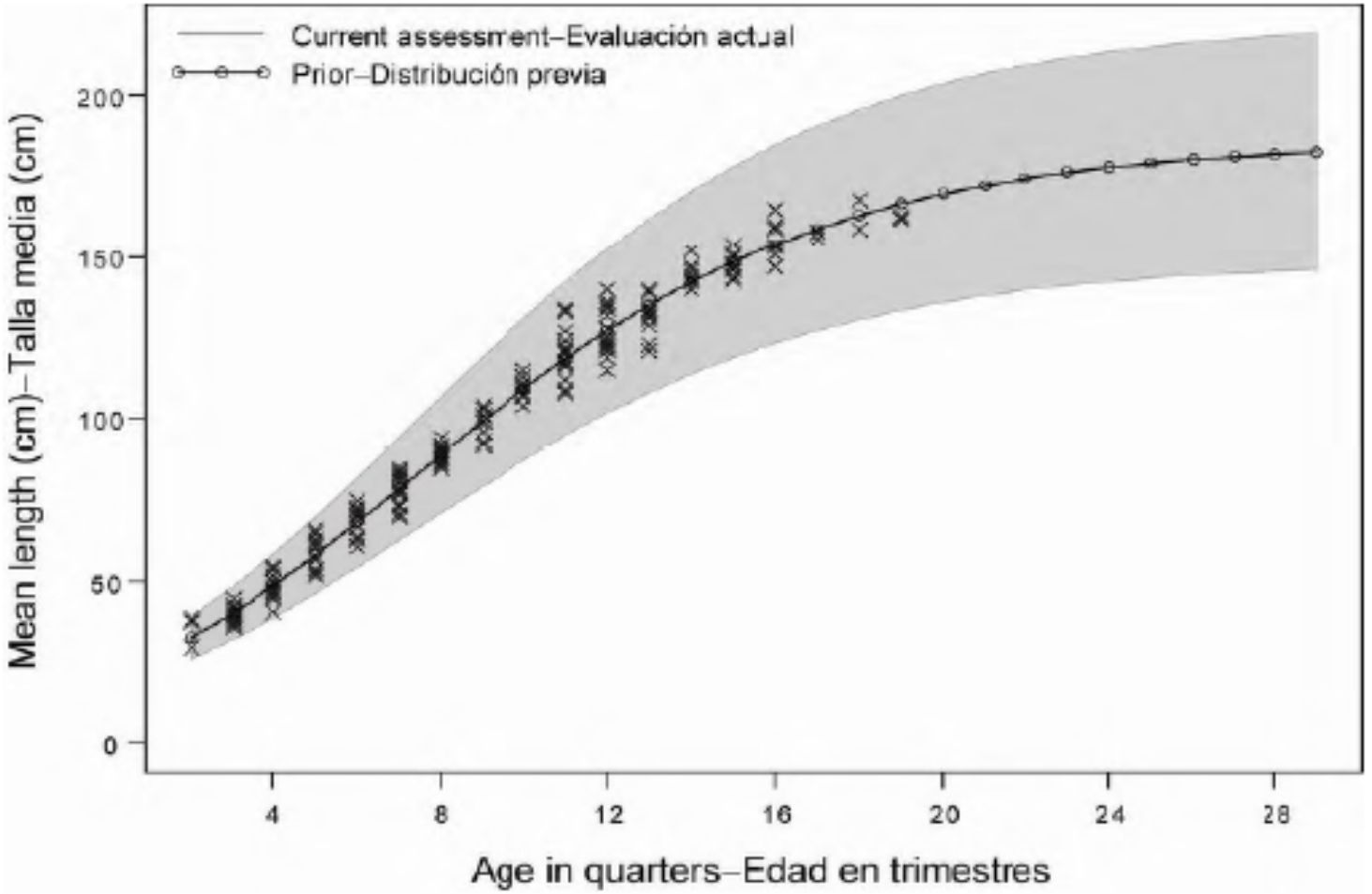


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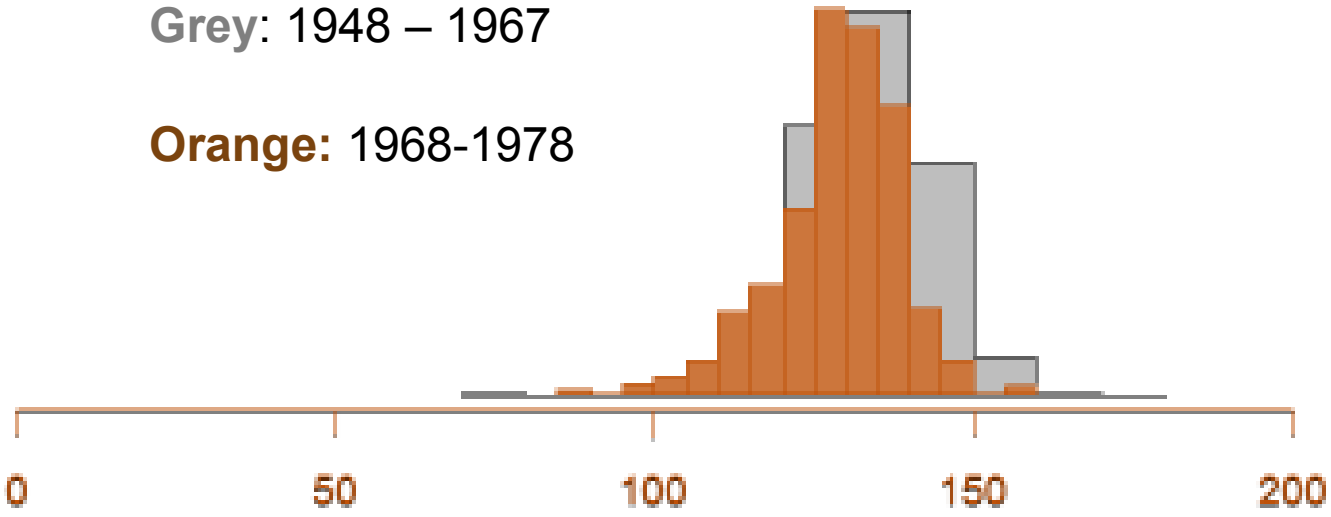
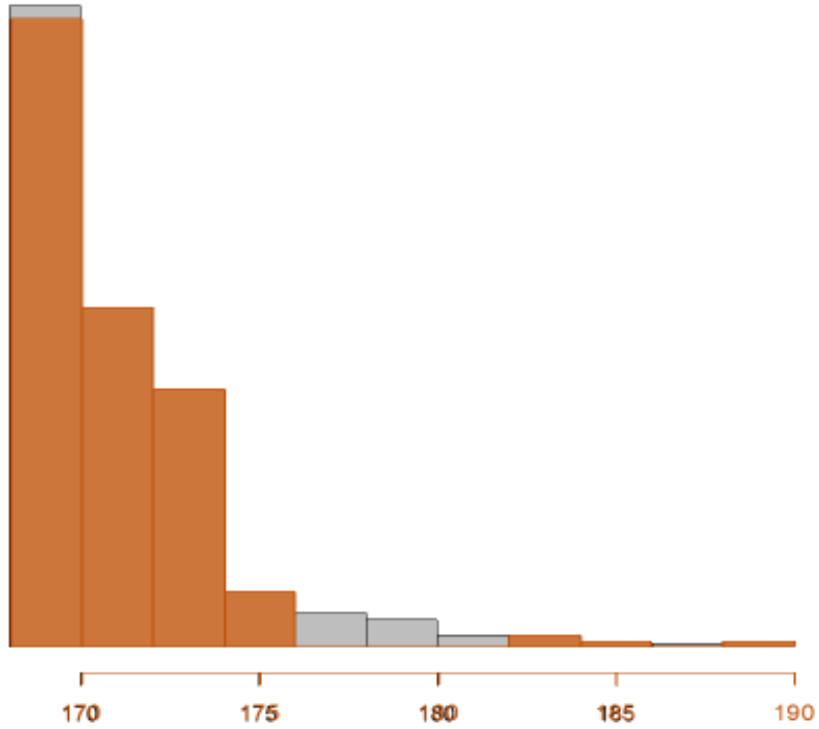
FIGURA 3.1. Curva de crecimiento usada para la evaluación del atún aleta amarilla en el OPO (línea

Estimation of growth in the stock assessment

historic times
Grey: 1948 – 1967

Orange: 1968-1978





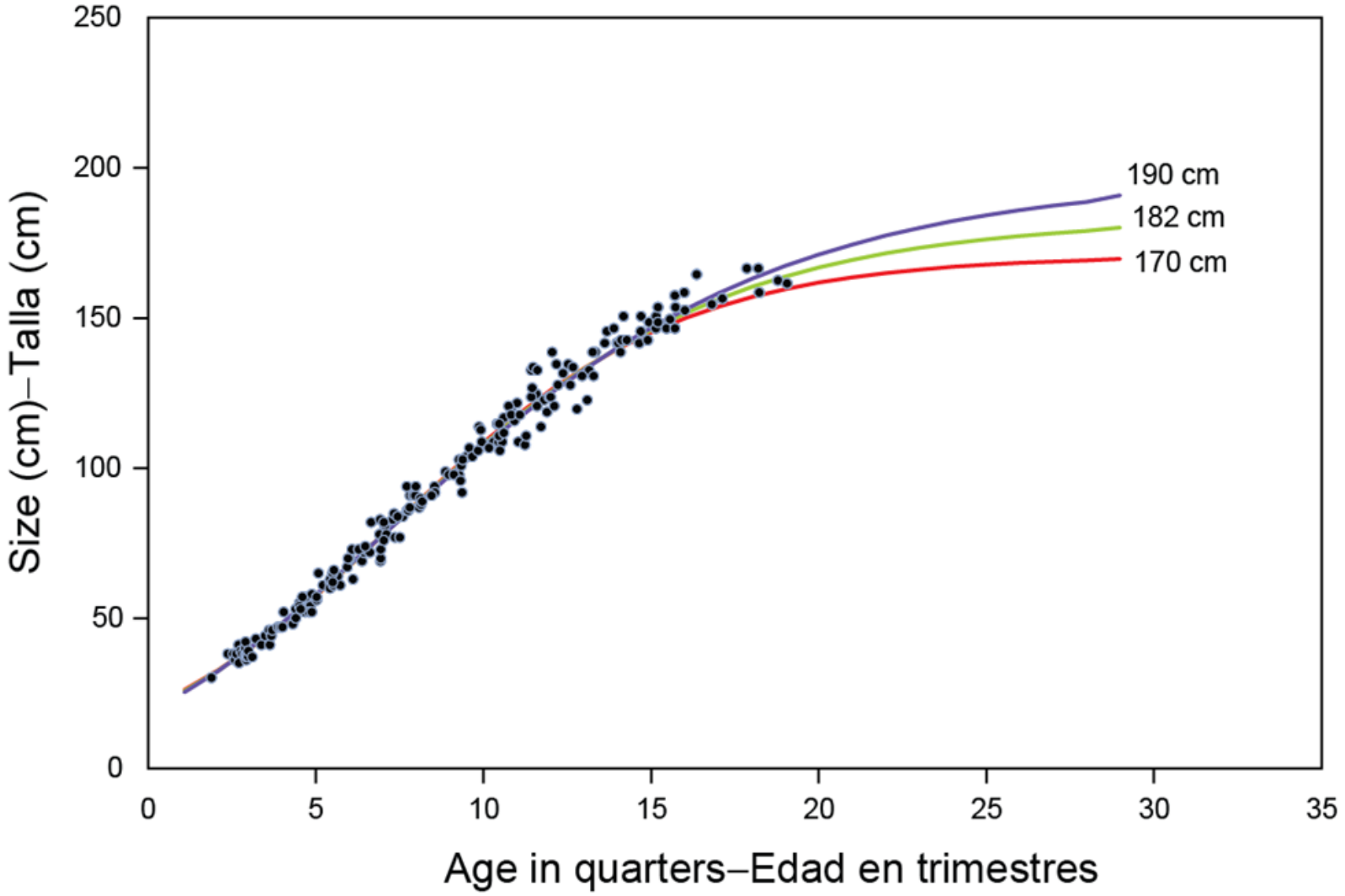
Fork length (cm)

0.5% of the catches correspond to animals with fork length larger than 168 cm. Of those, only extremely rarely a fish larger than 180 cm were caught

Estimation of growth in the stock assessment

Runs (with otolith data assigned to gender 1)	N par	NLL		L2	CV_L2 fem	K	offset males	CV_L2 male offset		K_males_offset
SAC7 BC with otolith data	276	9844		182.3	1.816	0.19	0	0		0
Estimate L2 with otolith data	277	9791		169.3	1.816	0.19	0	0		0
Estimate CV of L2 with otolith data	277	10103		182.3	-3.000	0.19	0	0		0
Estimate CV of L2 with otolith data, L2 fixed at 172 cm	277	9778		172.0	-1.592	0.19	0	0		0
Estimate L2 and CV of L2 with otolith data	278	9979		172.4	-1.784	0.19	0	0		0
Estimate L2 and CV of L2 for males and females with otolith data	279	9721		175.0	-0.528	0.19	0	-3	hit the lower bound	0

Sensitivity of stock assessment results to growth



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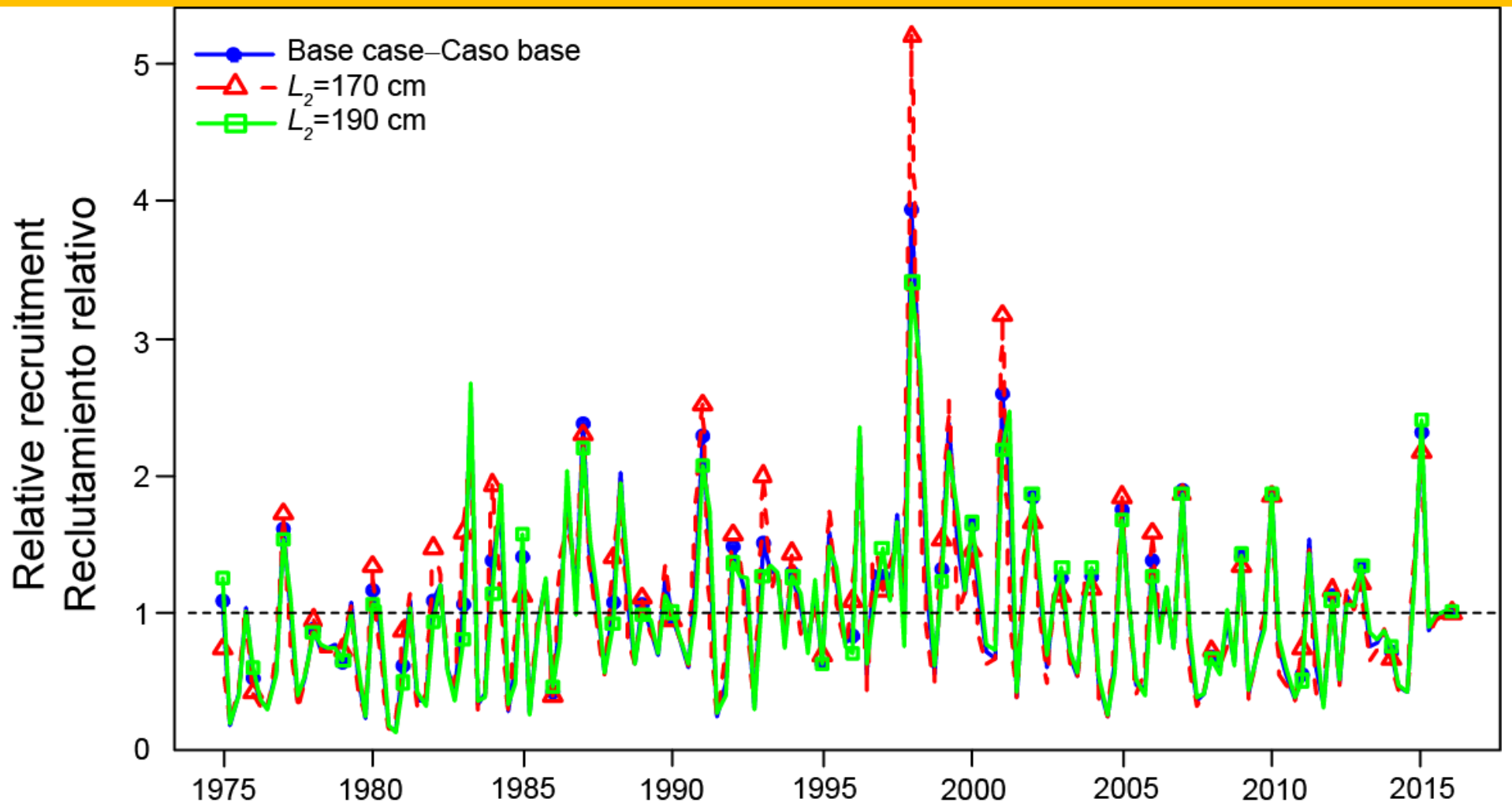
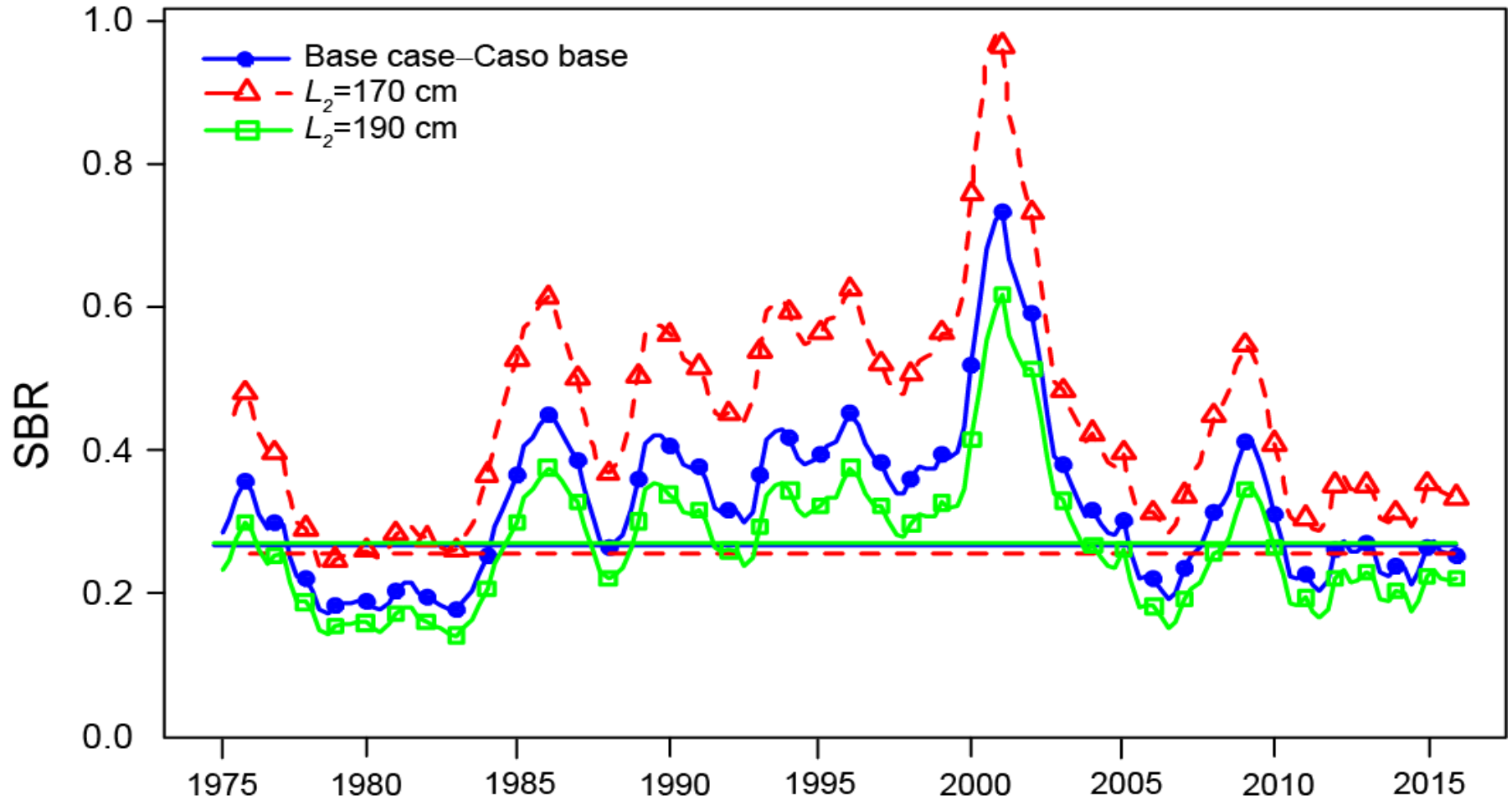


Sensitivity of stock assessment results to growth



Sensitivity of stock assessment results to growth

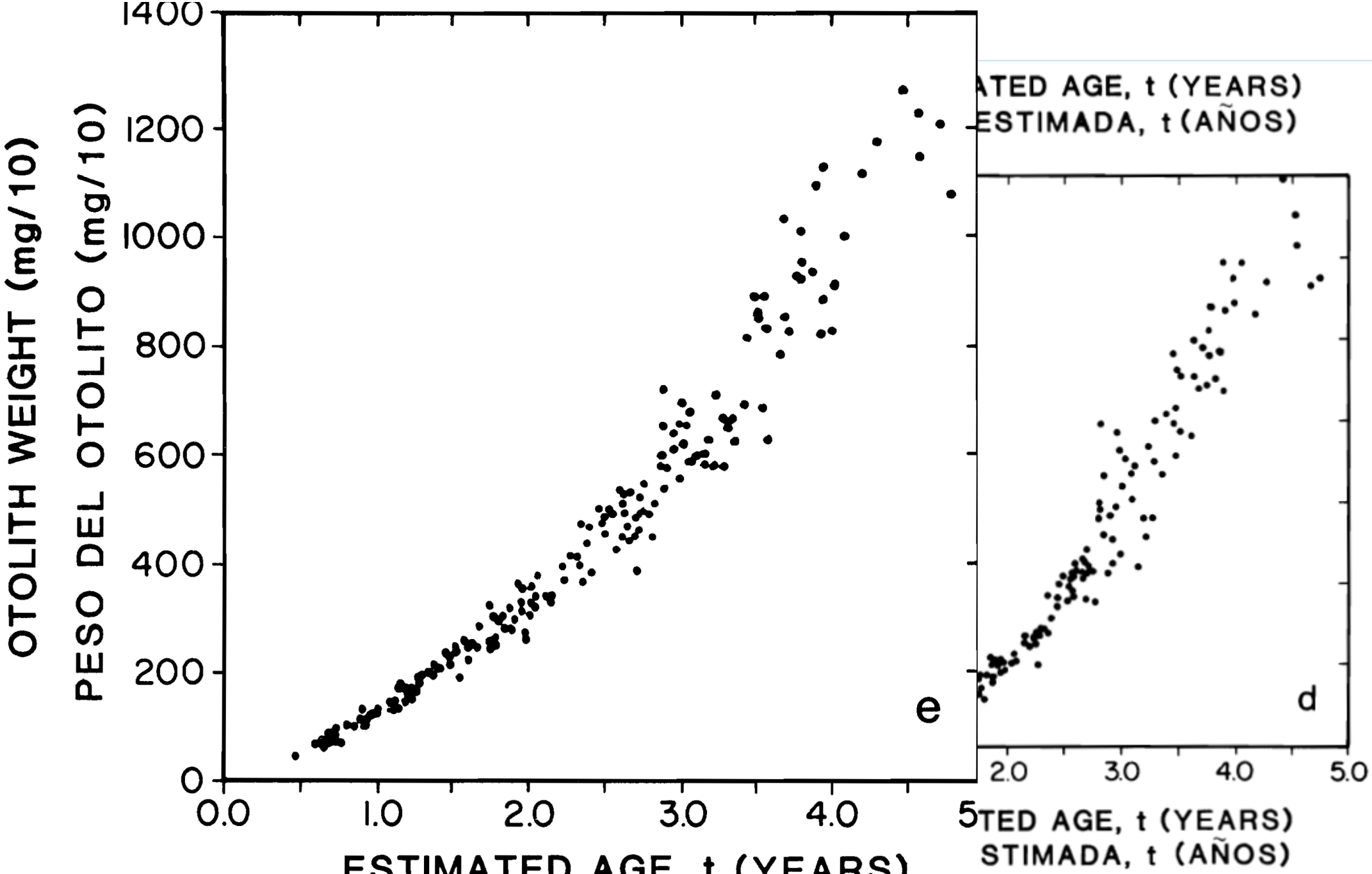
YFT	Base case Caso base	$h = 0.75$	$L_2 = 170$	$L_2 = 190$
MSY-RMS	272,841	287,476	288,672	272,782
B_{MSY}- B_{RMS}	372,010	547,238	395,744	374,461
S_{MSY}- S_{RMS}	3,528	5,897	4,152	3,627
B_{MSY}/B_0- B_{RMS}/B_0	0.32	0.37	0.32	0.33
S_{MSY}/S_0- S_{RMS}/S_0	0.27	0.35	0.26	0.28
C_{recent}/MSY- C_{recent}/RMS	0.94	0.89	0.89	0.94
B_{recent}/B_{MSY}- B_{recent}/B_{RMS}	0.96	0.64	1.18	0.82
S_{recent}/S_{MSY}- S_{recent}/S_{RMS}	0.95	0.56	1.3	0.74
F multiplier- Multiplicador de *F*	1.02	0.65	1.48	0.88

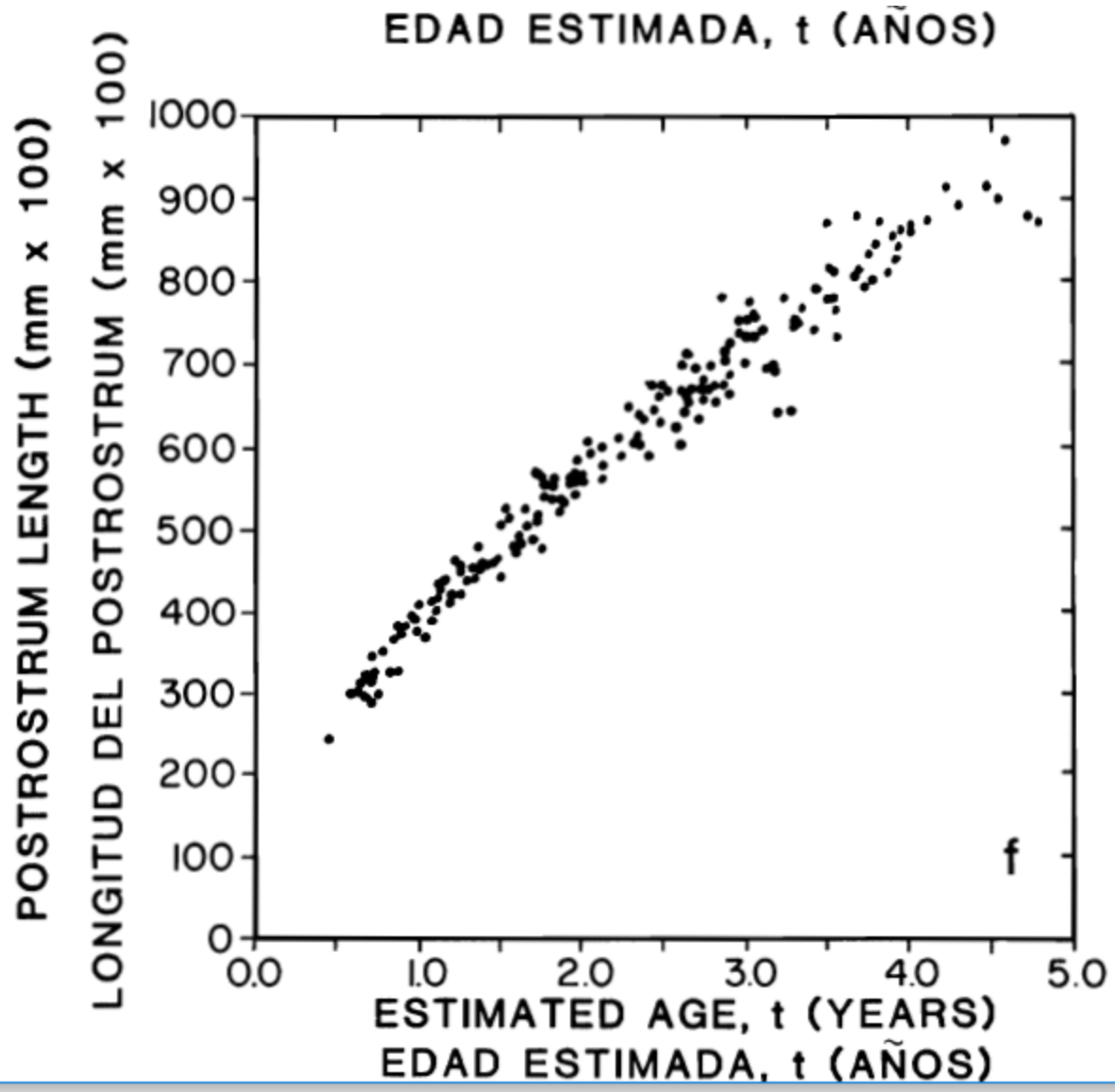
SAC 7 (2016)

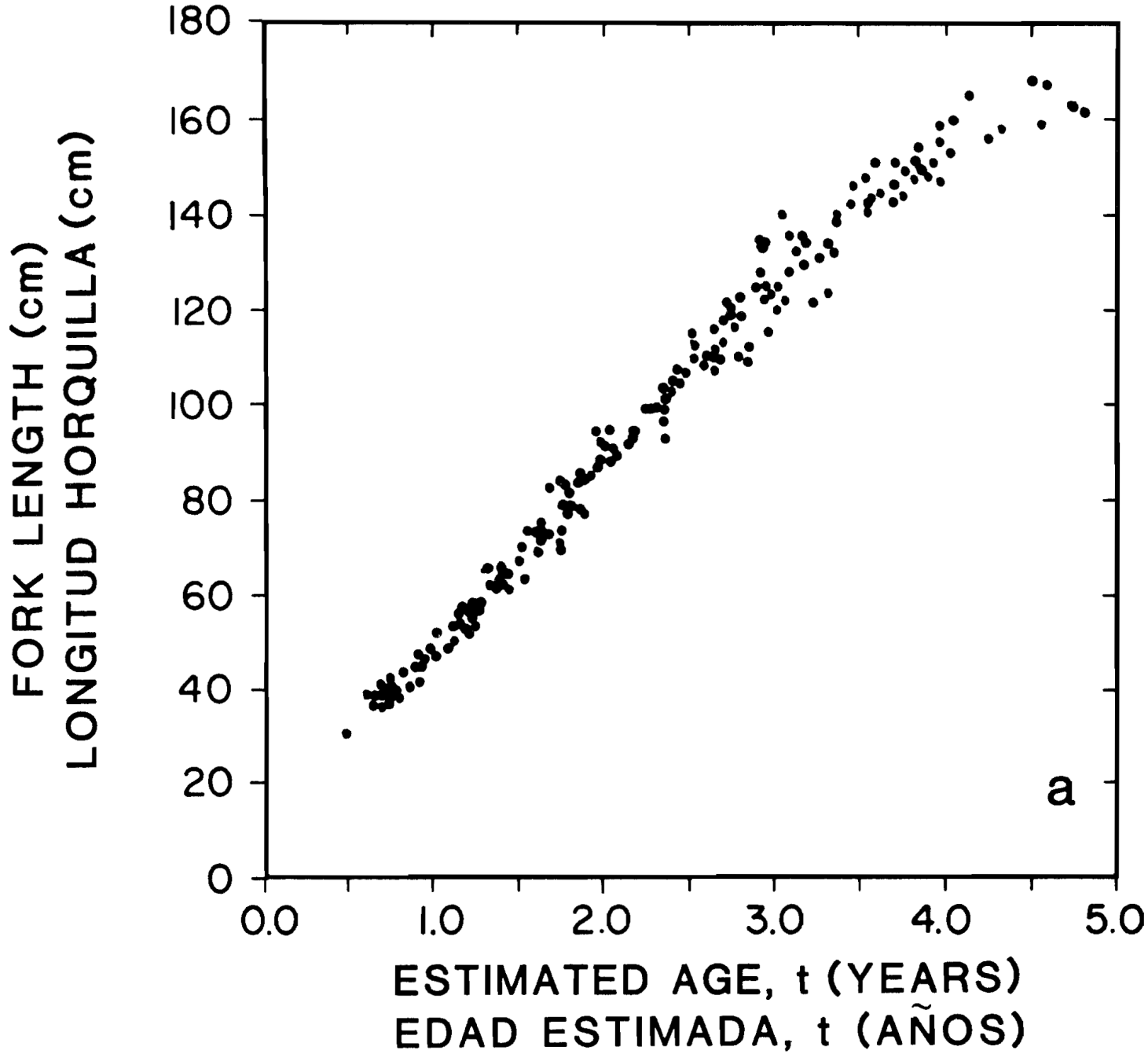
Thank you!

- During 1977 through 1979, the landings of 16 purse seiners were sampled
- opportunistically at San Diego, California, canneries to obtain 15 yellowfin in each
- 10-cm interval in the length range of 30-170 em. The fish were caught at different
- locations, but collectively they were confined to north of the equator and east of
- 137°W (Table 1). Because of otolith breakage, obstructions on the counting path
- of large otoliths and scarcity of large yellowfin in the 160-170 em length interval
- the final sample size included 196 fish.

- Table 2 includes 103 males and 59 females in the FL ranges of 52.3-167.6 em
- and 50.2-142.5 cm respectively. Females larger than 143 em are rarely caught
- in the purse-seine fishery (Anon., 1983: 43-44), and this fact is also demonstrated
- by the present sample despite its small size.
- The small sample size in 1978 prevented a comparison of the
- male and female FL growth curves, but their differences in 1977 (F.05(1, 76) = 12.8*). and 1979 (F.05(1, 63) = 10.3*) were both significant
- The sizes at age (Table 8) show a consistent
- trend in that young females are initially larger than males of the same age, the
- growth curves cross one another at the underlined sizes, and thereafter males
- are larger than females.


OTOLITH WEIGHT (mg/10)
PESO DEL OTOLITO (mg/10)
1400
1200
1000
800
600
400
200
0
0.0
1.0
2.0
3.0
4.0
5
ESTIMATED AGE, t (YEARS)
EDAD ESTIMADA, t (AÑOS)
e
ATED AGE, t (YEARS)
ESTIMADA, t (AÑOS)
2.0
3.0
4.0
5.0
d
TED AGE, t (YEARS)
STIMADA, t (AÑOS)


EDAD ESTIMADA, t (AÑOS)
LONGITUD DEL POSTROSTRUM (mm x 100)
POSTROSTRUM LENGTH (mm x 100)
1000
900
800
700
600
500
400
300
200
100
0
0.0
1.0
2.0
3.0
4.0
5.0
f
ESTIMATED AGE, t (YEARS)
EDAD ESTIMADA, t (AÑOS)


FORK LENGTH (cm)
LONGITUD HORQUILLA (cm)
180
160
140
120
100
80
60
40
20
0
0.0
1.0
2.0
3.0
4.0
5.0
ESTIMATED AGE, t (YEARS)
EDAD ESTIMADA, t (AÑOS)
a

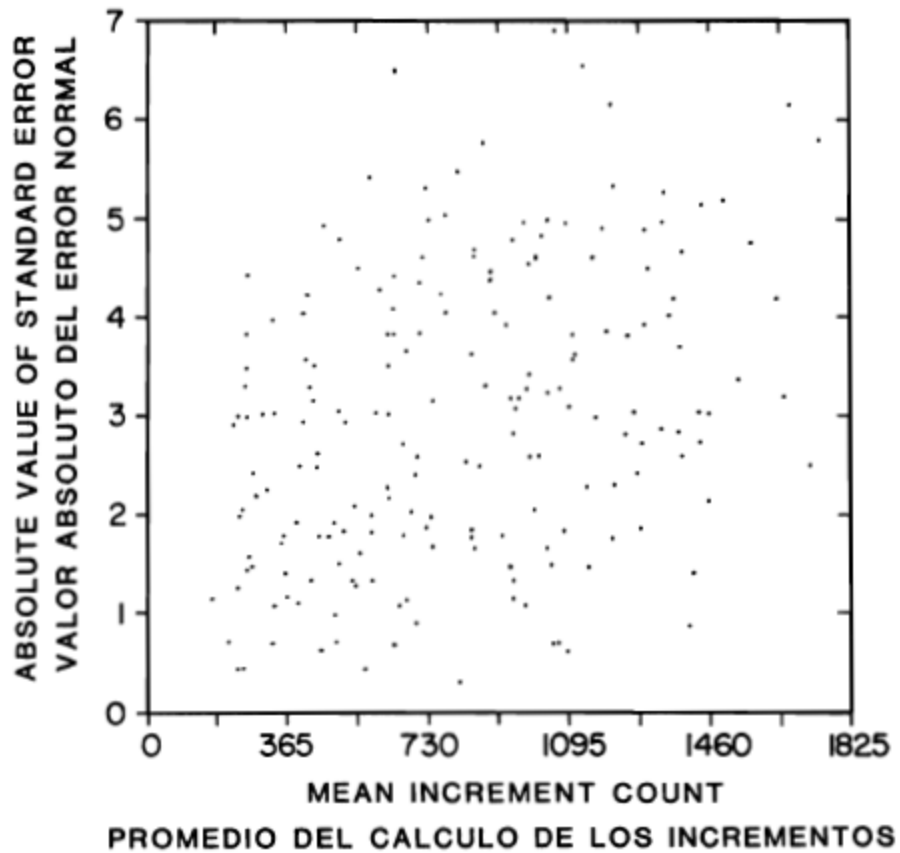
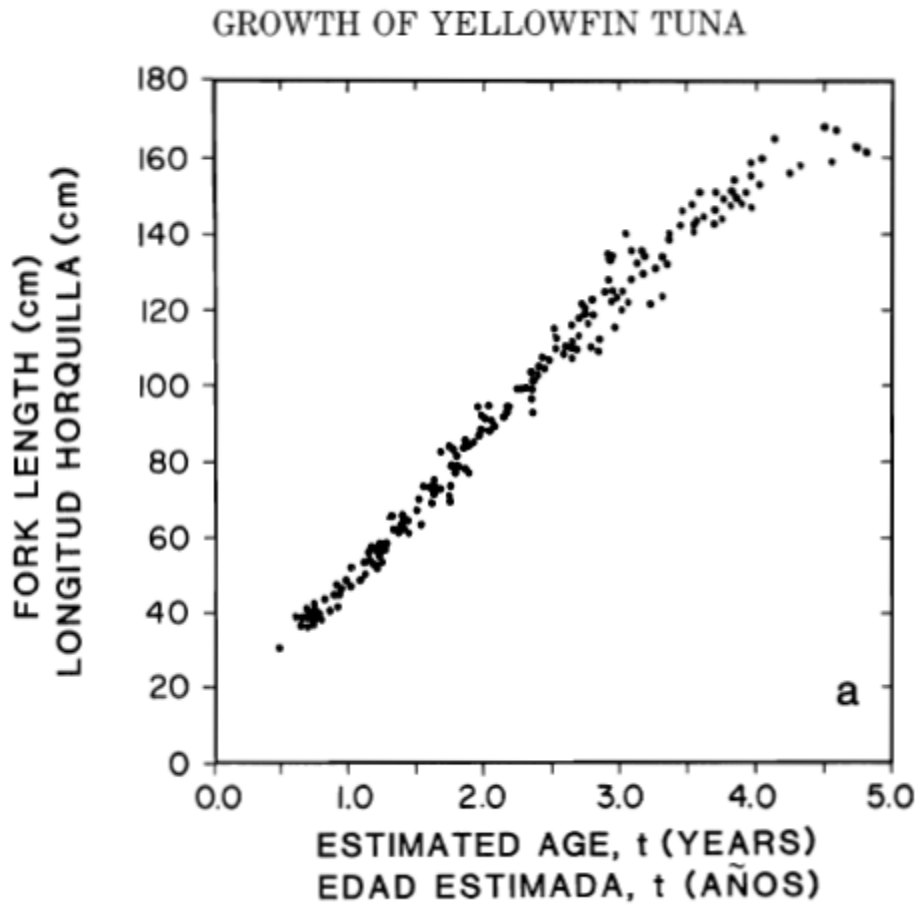
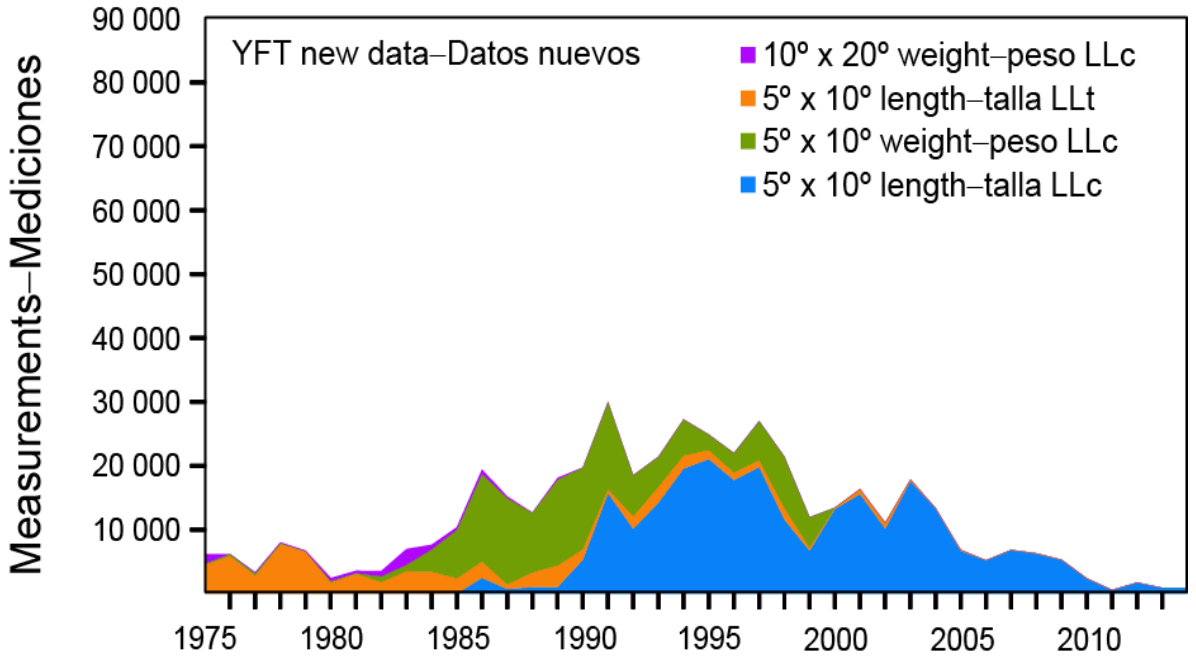


FIGURE 2. Scatter diagram of mean increment counts and their standard errors.


GROWTH OF YELLOWFIN TUNA
FORK LENGTH (cm)
LONGITUD HORQUILLA (cm)
180
160
140
120
100
80
60
40
20
0
0.0
1.0
2.0
3.0
4.0
5.0
a
ESTIMATED AGE, t (YEARS)
EDAD ESTIMADA, t (AÑOS)

Longline size data

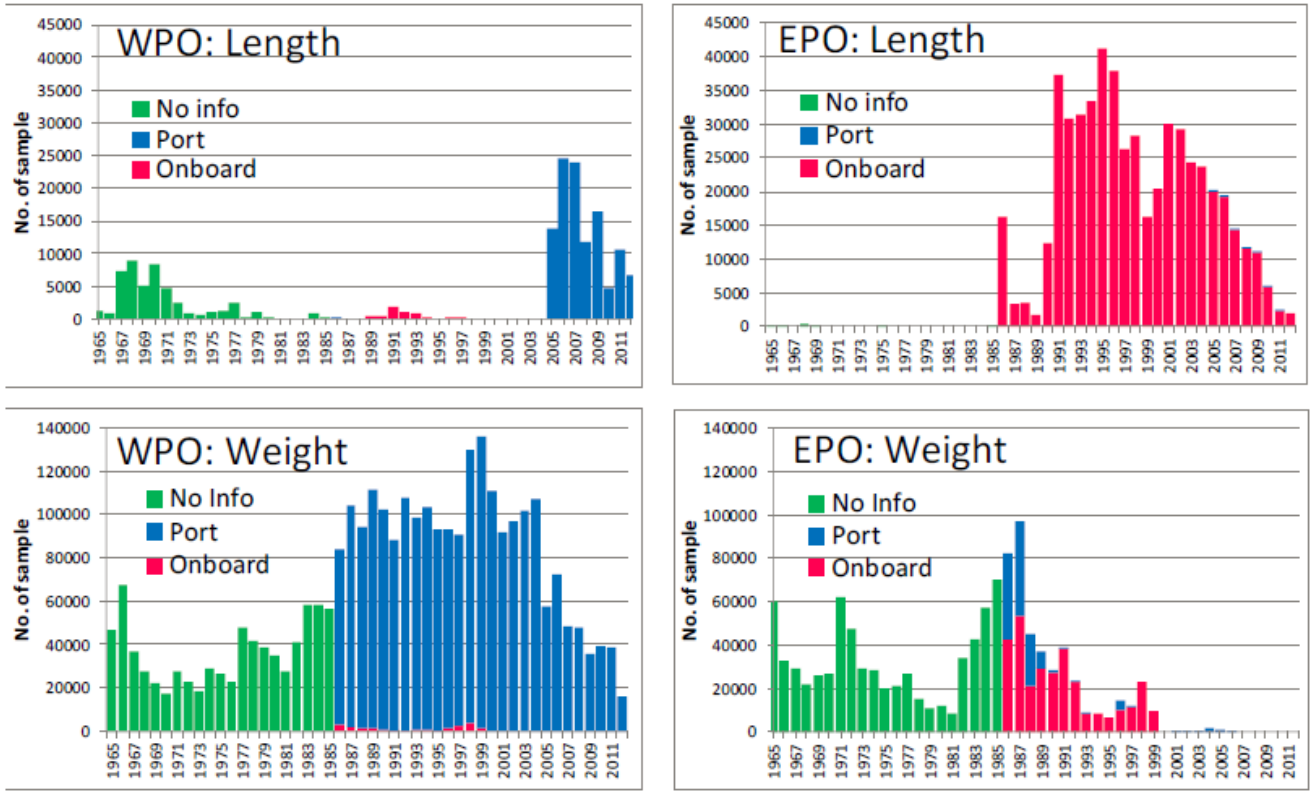
Yellowfin tuna



LLc: commercial longline vessel
LLt: longline training vessel

Details about the data

Type of size measurement by area in the Pacific Ocean



Okamoto (2014) SAC-05 INF-D

WCPO assessments : mainly use weight-frequency data
EPO: length-frequency data dominates in recent years

Summary

- Length-comp data are greatly down-weighted in the assessment
- The Richards growth curve is estimated outside the assessment model based on both length-at-age and tagging data
- L_∞ has a larger estimation uncertainty than K due to 1) limited sample size for >150cm bigeye and 2) difficulty in counting otoliths increment after age 4 yrs
- Both population attributes and management quantities are very sensitive to L_∞: $\uparrow L_\infty$ corresponds to $\downarrow SB_{recent}$ and $\uparrow F_{recent}$
- The assessment model reach maximum likelihood when $L_2 \approx 180$cm